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# Patient acceptability of remotely controlled cardiac MRI acquisition across 75– 1,200 km: a mixed-methods study across Denmark and the Faroe Islands

**Fabiola Søndergård van Wonterghem**
University of Copenhagen
**Maya Schambye**
Rigshospitalet
**Mathilde Løk**
University of Copenhagen
**Jan Jóanesarson**
Landssjúkrahúsið
**Anders Bruun Mathiasen**
Holbæk Sygehus
**Kim Madsen**
Rigshospitalet
**Søren Boesgaard**
Rigshospitalet
**Maria Kristiansen**
University of Copenhagen
**Niels Vejlstrup**
Rigshospitalet
**Morten Asp Vonsild Lund**
morten.lund@sund.ku.dk

University of Copenhagen

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# Abstract

**Background** Cardiac magnetic resonance imaging is central to cardiovascular diagnostics, yet access is uneven when specialist expertise is centralized. Remote acquisition technology has been clinically introduced to address the geographical inequality in access. In this study, we aimed to investigate patient characteristics and acceptability of remotely controlled cardiac MRI acquisition.

**Methods** This mixed-methods study was conducted at four hospital locations in Denmark and the Faroe Islands. Between November 2023 and May 2025, 123 patients underwent remote cardiac MRI acquisition. Of these, 67 (54.5%) completed a questionnaire on demographics, socioeconomic factors, and health literacy. Of 28 respondents volunteering for interview, 16 were interviewed. Data were analysed thematically informed by theories on patient perspectives on quality and access to care.

**Results** Participants were predominantly male (65.7%), aged 18-85 years, with high educational attainment (43.9% university-educated), labour-market attachment (68.7%), and high health literacy (78%). Thematic analysis identified one main theme, Engaging with remote MRI, with four subthemes: *Win-win, No difference, MRI as an alternative, and Economics and resources*.

**Conclusions** Participants prioritized specialist expertise while valuing reduced travel burden and described the experience of remote and conventional cardiac MRI as equivalent, with little additional patient-facing burden.

**Trial registration:**p-2023-15041

**Clinical trial number:** not applicable.


# Background

Cardiac Magnetic Resonance Imaging (cardiac MRI) is guideline recommended across multiple cardiac indications and used in diagnostic evaluation and monitoring of both acute and chronic patients with heart disease or indications hereof [1]. A cardiac MRI can describe the structure and function of the heart and diagnose diseases in the aorta [2, 3]. Despite growing volume and availability across the U.S. and Europe, geographical disparities in the access to cardiac MRI remains, particularly in rural areas where social disparities further exacerbate inequality in need and access to cardiac health care [1, 4]. Studies have further indicated that > 80% of OECD countries demonstrate distance decay, that is, worse outcomes and delayed diagnosis, for patients travelling farther for specialist care [5].

Geographical disparities in the access to cardiac MRI overall reflects centralized specialist expertise, global shortages of skilled operators, and persistent barriers including limited scanner access, costs, and sparse structured training, together prolonging waiting times and travel burden for patients [6–10]. Furthermore, there is a growing global issue with population ageing, which is expected to cause a great shortage of specialized and general health care providers, most likely to impact rural areas the most,

thereby increasing the inequality in access to cardiovascular healthcare even greater in the coming years and decades [11, 12].

Digitally enabled delivery of expert care offers a different response to this problem than the conventional options of expecting patients and specialists to relocate. Remotely controlled cardiac MRI acquisition is one such technology, referred to in the following as remote MRI. Unlike teleradiology, which relocates interpretation, remote MRI separates the operator from scanner: specialist operators perform real-time acquisition over secure digital networks from remote operator workstations, which do not need be physically located with either the MRI-scanner or the tertiary centre. On-site Patient Managers, trained in MRI safety but not in cardiac MRI-acquisition, provide patient positioning and safety oversight [13]. Thereby, patients referred to a cardiac MRI can receive the scan at their local hospital instead of further away at a specialized unit.

Digitalization of the healthcare system has been shown to both reduce and (re)produce social inequality [10, 14]. This underscores the need for research of the patient demographic, socio-economic status and experience of remote MRI. Other studies have previously described the technology behind remote MRI, important aspects when implementing remote MRI, and the user experience [13, 15, 16].

This mixed-methods study evaluated patient acceptability of remote cardiac MRI across a multi-site pilot (Denmark and the Faroe Islands; 75 – 1,200 km operator-scanner separation). Study aims were to: 1) characterize the demographic, socioeconomic, and health literacy profiles of clinician-referred patients; 2) explore patient-reported experiences, perceived benefits and concerns, and effects on treatment burden; and 3) describe who was and was not reached during pilot implementation, to identify early equity risks.

## Methods

# Study design

This study used a mixed-methods design, combining questionnaires and semi-structured interviews [17]. The questionnaire covered demographics, self-assessed health, and health literacy, in order to characterize participants' socioeconomic status and health profile. Semi-structured interviews explored patients' perspectives on remote cardiac MRI acquisition, disease navigation, and experiences with the healthcare system. This study followed the Consolidated Criteria for Reporting Qualitative Research guidelines [18]. Further, the study was reported to the relevant authorities in Denmark and the Faroe Islands (p-2023-15041; DBA ID: 137) and comply to the Declaration of Helsinki and the General Data Protection Regulation [19–21].

Participants received written information of their rights, the study's aim and procedure before giving their written consent. Prior to interviews, informants were verbally re-informed before giving verbal consent. All data was pseudo anonymized and stored securely. According to Danish regulation and guidelines, there was no need for ethical review due to the study not including biological material [22]. The data

which supports the presented findings are available from the corresponding author if requested reasonably.

## Setting

The service of remote cardiac MRI acquisition was implemented as a clinical pilot beginning in 2023. The tertiary centre, Rigshospitalet (Copenhagen, Capital Region), was connected to MRI scanners at three hospitals: Holbæk Hospital (Holbæk, Region Zealand; 75 km), Bornholm Hospital (Rønne, Capital Region; 150 km), and Landssjúkrahúsið (Tórshavn, Faroe Islands; 1,200 km). At each site, an on-site Patient Manager provided patient care, while all cardiac MRI sequences were acquired remotely by specialist operators employed at Rigshospitalet. Operators worked from remote operator workstations at Rigshospitalet, from dedicated home workstations, or from secure laptops. All connections used the Siemens Syngo Virtual Cockpit platform [23] over the hospital network, integrated across the four hospitals' separate IT networks in two Danish regions and the Faroe Islands. Access, authentication, and data handling were governed by regional IT security and General Data Protection Regulation requirements. All 123 scans performed during the pilot were completed without safety incidents and were assessed by regular health care staff as having full diagnostic quality comparable to conventional on-site acquisition.

Since the pilot period described here, remote cardiac MRI has continued as an ongoing clinical programme in the Kingdom of Denmark. It has more recently been extended, on a pilot basis, to non-cardiac MRI. By September 2026, more than 550 remote MRI examinations had been performed across ten hospitals, approximately 270 of them cardiac. The present analysis is confined to the first 123 cardiac examinations, during which questionnaire and interview data were collected. Patient experience has not been systematically assessed in the wider programme, in which examinations are performed as part of clinical care across heterogenous settings, indications, and examination types.

## Data Collection

# Participants and recruitment

Eligible patients were those referred by local cardiologists at the three participating hospitals for remote cardiac MRI during the pilot phase. This referral-based recruitment produced an implementation sample rather than a statistically representative cohort. Inclusion criteria were age ≥ 18 years, a remote cardiac MRI scan performed within the pilot project, and sufficient Danish comprehension to provide informed consent. No additional criteria regarding disease or indication were applied.

Of the 123 eligible patients, 67 (54.5%) completed a questionnaire and 16 took part in an interview (Fig. 1). Local healthcare personnel recruited participants face-to-face on the day of the scan; 15 Faroese participants were recruited after the scan by their treating cardiologist (J.J.) because of time

constraints. Five (6.2%) patients declined and 51 (41.5%) were not approached. Reasons were documented for 13 (insufficient time to obtain consent within the clinical workflow) but not for the remaining 38; non-approach was not systematically recorded, so logistical non-recruitment cannot be distinguished from clinician gatekeeping (detailed breakdown in Fig. 1). Of the 67 questionnaire respondents, 28 indicated interest in an interview. Sixteen were interviewed, four did not respond, and eight were not contacted. No sample size was set in advance, instead analysis ran concurrently with interviewing, and recruitment stopped when the research team judged data saturation.

# Questionnaires

Questionnaires were administered in Denmark and the Faroe Islands between November 2023 and May 2025. Paper questionnaires were collected and entered into REDCap (Research Electronic Data Capture) [24, 25] by F.S.W.. The questionnaires covered demographics and socioeconomic factors (psychosocial support, employment or education status, comorbidities) (Figure S1). Gender was self-reported (male/female/other). No gender-stratified analyses were conducted, given the descriptive design and limited sample size. Health literacy was assessed using ten items from the Australian Health Literacy Questionnaire,[26] previously validated in a Danish population [27].

## Semi-structured interviews

Semi-structured interviews were conducted and audio-taped in January and February 2025, guided by an interview guide with open-ended questions (Figure S2). The interviewer (F.S.W.) introduced herself and the study rationale, after which participants introduced themselves. Initial questions explored elements considered essential to a coherent patient journey. Later questions addressed timelines from symptom onset to remote cardiac MRI, and experiences with remote diagnostic processes. Field notes documented observations not captured in the audio recordings. Interviews were held with only the participant and interviewer and took place in meeting rooms at local hospitals (n = 3), online (n = 11), at a participant's workplace (n = 1), or in a participant's home (n = 1), according to participant preference. Only the participant and interviewer were present. Audio-recorded interviews lasted 40–90 minutes. Viceron AI [28] generated initial transcriptions, which F.S.W. reviewed and edited to verbatim. No repeat interviews were conducted, and participants did not review transcripts.

The interviewer (F.S.W.), employed as project coordinator and research assistant at Rigshospitalet's Department of Cardiology for the remote cardiac MRI project, is female, aged 27, with prior qualitative research experience. She had no prior relationship with participants but was raised near Holbæk Hospital.

# Data Analysis

REDCap [24, 25], hosted in the Capital Region, Denmark, stored questionnaire data and supported descriptive distributions (Tables 1 and 2). MAXQDA [29] supported thematic analysis of transcribed interviews following Braun and Clarke's methodology [30]. Interviews were analysed by the first author

(F.S.W.) within a phenomenological framework, with coding discussed with co-authors to discuss and elaborate interpretations. However, the interview guide's focus on the remote MRI was decisive for the analytical focus. F.S.W. had full access to all data and takes responsibility for their integrity and for the data analysis.

Table 1
Characteristics of Questionnaire and Interview Participants

| **Gender** | **Questionnaire (N = 67)** | **Interview (N = 16)** |
|---|---|---|
| Male | 44 (65.7%) | 13 (81.25%) |
| Female | 23 (34.3%) | 3 (18.75%) |
| Age | | |
| 18–30 | 6 (9.0%) | 0 (0%) |
| 31–50 | 18 (26.9%) | 5 (31.25%) |
| 51–60 | 22 (32.8%) | 8 (50%) |
| 61–70 | 13 (19.4%) | 2 (12.5%) |
| 71–85 | 8 (11.9%) | 1 (6.25%) |
| Connection to labour market or education | | |
| Yes | 46 (68.7%) | 12 (75%) |
| Civil status | | |
| Partner | 52 (77.6%) | 12 (75%) |
| Single | 13 (19.4%) | 3 (18.75%) |
| Other | 2 (3.0%) | 1 (6.25%) |
| Do you have anyone to talk to if you have problems or need support? | * | |
| Yes, often | 53 (80.3%) | 14 (87.5%) |
| Yes, sometimes | 7 (10.6%) | 2 (12.5%) |
| Yes, but rarely | 5 (7.6%) | 0 (0.0%) |
| No | 1 (1.5%) | 0 (0.0%) |
| Which level of education have you completed? | * | |
| Primary school | 12 (18.2%) | 3 (18.75%) |
| High school or vocational | 25 (37.9%) | 5 (31.25%) |
| University degree | 29 (43.9%) | 8 (50.5%) |
| *One missing item, †Two missing items. | | |

| Gender | Questionnaire (N = 67) | Interview (N = 16) |
|---|---|---|
| Comorbidities (Current or prior) | | |
| Diabetes | 4 (6%) * | 1 (6.25%) |
| Chronic obstructive pulmonary disease | 2 (3%) * | 0 (0.0%) |
| Musculoskeletal disorder | 15 (23.1%) † | 3 (18.75%) |
| Cardiac disease | 39 (59.1%) * | 9 (56.25%) |
| Cancer | 12 (18.2%) * | 1 (6.25%) |
| Psychiatric disorder | 11 (16.7%) * | 4 (25.0%) |
| How would you describe your overall health? | † | |
| Excellent | 2 (3.1%) | 0 (0.0%) |
| Very good | 11 (16.9%) | 5 (31.25%) |
| Good | 39 (60.0%) | 8 (50.0%) |
| Less good | 9 (13.8%) | 2 (12.5%) |
| Poor | 4 (6.2%) | 1 (6.25%) |
| *One missing item, †Two missing items. | | |

Table 2
Patient experience related to Remote MRI scan

| Site of Remote MRI scan | Questionnaire (N = 67) | Interview (N = 16) |
|---|---|---|
| | No. (%) | No. (%) |
| Holbæk | 25 (37.3%) | 5 (31.25%) |
| Bornholm | 18 (26.9%) | 6 (37.5%) |
| Tórshavn | 24 (35.8%) | 5 (31.25%) |
| Remote MRI as part of diagnostic work-up or monitoring? | * | |
| Diagnostic workup | 29 (47.5%) | 6 (37.5%) |
| Monitoring | 32 (52.5%) | 10 (62.5%) |
| Did you receive the information you felt you needed before the scan you are going to receive today? | | |
| Not at all | 1 (1.5%) | 0 (0.0%) |
| Almost not | 5 (7.5%) | 0 (0.0%) |
| Appropriate | 61 (91.0%) | 16 (100%) |
| Too much | 0 (0.0%) | 0 (0.0%) |
| How worried are you about the scan you are going to receive today? | | |
| Very worried | 1 (1.5%) | 0 (0.0%) |
| A little worried | 16 (23.9%) | 3 (18.75%) |
| Neutral | 9 (13.4%) | 2 (12.5%) |
| Not worried | 21 (31.3%) | 4 (25.0%) |
| Not at all worried | 20 (29.9%) | 7 (43.75%) |
| *Six missing items. | | |

# Results

# Case illustration

The following three cases illustrate the range of patient experiences and treatment burdens relevant to remote cardiac MRI:

**Case 1**

(ID02 Carl) is a physically active father living with an aortic aneurysm. Early in his diagnostic journey, he wanted to speak with a specialized cardiologist to gain knowledge to navigate his disease. He had questions such as: Can I work out like I normally do? Carl is monitored every year. For him, remote cardiac MRI has made it possible to have a cardiac MRI performed instead of a cardiac CT scan, reducing the lifetime exposure for ionizing radiation. Likewise, the strong connection between local staff and specialized staff has given Carl access to information he needed to navigate his diagnosis.

**Case 2**

(ID25 Oscar) is also a father. He lives with multiple chronic and complex conditions limiting the timespan where he is not a patient. During the last year he had 18 hospital admissions, more than 50 outpatient visits, and at least 130 visits to the health clinic. When he travels to Rigshospitalet in the Capital Region, he exhausts his daily resource capacity of approximately three days, despite travelling only one day. Remote cardiac MRI has changed this, now he can drive himself to the local hospital. Oscar reports that digital solutions such as remote cardiac MRI have significantly reduced his treatment burden.

**Case 3**

(ID17 John) a physically active retiree, experienced sudden difficulty breathing. X-ray and electrocardiogram showed no sign of a cardiac issue, leaving his GP to diagnose him with asthma. For six months, he slept while sitting up and stopped his usual sports activities, isolating him from friends. In yet another visit to his GP, John insisted they do something more. This led to a local hospital admission, where an echocardiography showed a reduced ejection fraction. He was then told to stop all asthma medication. To rule out any other cardiac conditions, he was also examined with a remote cardiac MRI.

# Participant characteristics

The 67 questionnaire respondents (54.5% of 123 eligible patients) represent an initial clinician-selected cohort recruited under real-world constraints. Responders and non-responders did not differ significantly in scan type (diagnostic work-up vs monitoring; $\chi^2 = 0.02$, $P = .90$) or scan site ($\chi^2 = 4.55$, $P = .10$) (Table S1). The responder profiles, summarized in Table 1, provide context for the qualitative themes that follow.

Participants were predominantly male (65.7%), aged 18 to 85 years (median age group 51–60 years). Educational attainment was high: 43.9% held a university degree and 37.9% had completed high school or vocational training. Although 59.1% reported current or prior cardiac conditions and 11.9% were aged 70 years or older, most participants (68.7%) remained connected to the labour market or education.

Social support was strong: 77.6% had partners, and more than 80% reported having someone to talk to “often” when they needed support. Self-rated health was largely positive, with 80.0% describing their health as “good”, “very good”, or “excellent”, and 20.0% rating it as “less good” or “poor”.

Participants were distributed across the three sites: Holbæk (37.3%), Bornholm (26.9%), and Tórshavn (35.8%). Scans were divided between diagnostic work-up (47.5%) and monitoring (52.5%), reflecting the high prevalence of existing cardiac conditions. Before the scan, 91.0% felt appropriately informed, and more than 60% reported being “not worried” or “not at all worried”. Health literacy scores were high (Table S2): more than 78% rated all items as “easy” or “very easy”, with most items exceeding 90%.

Sixteen questionnaire respondents were interviewed. Compared with all respondents (n = 67), interviewees were more often male (13 of 16 (81.3%) vs 65.7%) and more often aged 60 years or younger (13 of 16 (81.3%) vs 68.7%) (Tables 1 and 2). Comorbidity profiles were similar in the two groups.

[INSERT Table 1 HERE]

[INSERT Table 2 HERE]

# Thematic analysis: Engaging with remote MRI

Analysis identified one main theme, Engaging with remote MRI, encompassing four subthemes: Win-win, No difference, MRI as an alternative, and Economics and resources (Fig. 2).

# The Thematic Map depicting the Main Theme with Sub Themes

# Win-win

Eleven of the 16 interview participants had travel times exceeding one day, because of flights or car and ferry combinations. Participants nonetheless considered access to healthcare professionals with the necessary knowledge, skills, and routine more important than the length of the journey.

"*I don’t feel the need for a nearby healthcare system. I’d much rather be treated by someone who’s highly skilled, even if it means I have to drive [far] for an examination*." (ID16 Henry)

Several participants used the phrase “*win-win*” to describe remote MRI, referring to the combination of shorter travel time and access to specialist healthcare professionals.

"ID26: *(...) But exactly this [remote MRI], it combines the good with the good.*

Interviewer: *What do you mean by 'the good with the good'?*

ID26: *The good with the good is that it's close by, meaning I don't have to spend the whole day traveling over there. And it combines the good with the fact that it's professionals, like highly specialized people, who are doing it. So, it can almost only be a win-win*." (ID26 Benjamin)

"*I mean, we're out here in West Zealand, it's a wasteland when it comes to doctors and expertise in general. (…) So, if we can bring the expertise in somehow, without them needing to be physically present, then I think it's a win-win for everyone*." (ID44 Susan)

Other participants described the remote element as a "*no-brainer*" (ID18 Brian), as making "*perfect sense*" (ID22 Paul), and as "*brilliant*" (ID44 Susan).

"*I think that, at first glance, on the surface, it seems a bit like a no-brainer, if it makes sense financially and logistically.*" (ID18 Brian)

"*(...) when he [the cardiologist] mentioned it, I just said, go ahead and sign me up, because it made perfect sense for everyone involved, right?*" (ID22 Paul)

"*I thought it was cool. Like, that you didn't have to go all the way to Rigshospitalet [Capital Region Hospital] if someone from there needed to have a look. So, I think it's great that you can have the specialist nearby (…) I think that's just brilliant. It's kind of reassuring, in a way*." (ID44 Susan)

For other participants, remote technology addressed a situation in which patients can feel left behind.

"*And again, if the best doctors absolutely want to live in Copenhagen [capital city], then they should be allowed to do that. And in those situations, I'll just have to adapt. But remote can be a good way to manage it.*" (ID16 Henry)

The tension between accepting that clinicians may live where they choose and expecting equal access to healthcare left Henry feeling that he must adapt to the healthcare system rather than the system adapting to him. He recognized that remote technology could help "*manage it*", reducing the need for him to adapt.

# No difference

Participants reported that the specialized cardiac MRI service, previously available only at the tertiary hospital, was now delivered at their local hospital without perceptible difference in the experience of the examination. Thirteen participants ended the interview by stating that they had not fully understood the purpose of the interview beforehand, because their experience did not differ from conventional cardiac MRI. The words *"no difference*" were used in most interviews by participants able to compare with previous conventional scans.

"*From arrival, everything you go through beforehand; the prep before going into the machine, going through the scan, coming out, getting changed. All of that was exactly the same. I would never have known [it was remote] if no one had told me. It made no difference.*" (ID18 Brian)

"*There's no difference between the staff, they're equally professional. They know what to say. They tell you to lie down like this, and they explain everything. (…). There's absolutely no difference.*" (ID32 James)

For several participants, the service offered reassurance against the insecurity of living far from acute care, with a shared sense that remote technology could bring specialist healthcare to where patients live.

# MRI as an alternative

A subgroup of participants had previously undergone cardiac CT rather than cardiac MRI. For them, access to cardiac MRI reduced concern about side effects during monitoring appointments.

"*Because I've always just had CT scans. And then last time I told him [the cardiologist]: 'I refuse. I'm not doing CT scans anymore, because I'm young, there's so much radiation. I don't want it.' (…) But I also want to feel safe. I don't want 'not' to be scanned either. I want to feel safe. That's really important.*" (ID46 Mary)

For Mary and others previously undergoing monitoring CT, it was not only easier access closer to home but the opportunity to undergo cardiac MRI at all that enhanced their sense of safety and needed access to advanced imaging.

# Economy and resources

Thirteen of the 16 participants raised economic considerations without prompting. The Kingdom of Denmark has a tax-funded public healthcare system in which patients have free access to care when it is medically indicated. Taxpayers ultimately bear the consequences of how resources are allocated, and participants were aware of this.

"*So, it [the remote MRI] was very professional and very factory-like. They need to get a lot through, and it's important that my tax money is used properly. That's completely fine.*" (ID07 Finn)

*"If you get more efficiency out of things, (…) then we get a better healthcare system, because the money goes further, and I get more for my taxes."* (ID32 James)

Efficiency echoed across most interviews. Participants weighed whether remote MRI would increase or reduce the use public funds. This suggests that positive patient experience includes the perception of an efficient workflow that uses resources in a sustainable way.

## Discussion

This mixed-methods study characterized the demographic, socioeconomic, and health literacy profile of patients referred for a remote cardiac MRI during pilot implementation and explored their lived experiences of the service. The clinician-referred cohort combined a substantial cardiac disease burden with high socioeconomic status and high health literacy. Participants consistently described the model as a "win-win" that combined reduced travel burden with continued access to specialist expertise.

Thirteen of the 16 interviewees reported no perceptible difference from conventional MRI, and participants expressed confidence in specialist oversight despite the operator being physically absent.

Participants experienced three benefits. First, local access reduced treatment burden for working-age patients attending for regular surveillance. Of questionnaire respondents, 68.7% were in work or education and 52.5% attended for monitoring. Eleven of the 16 interviewees had travel times exceeding one day, and one described a single one-day hospital journey consuming approximately three days of personal capacity. Second, unprompted economic reasoning reflected an awareness of resource allocation in a tax-funded system, and many described remote acquisition in general as both personally beneficial and systemically efficient. Third, the service expanded diagnostic options, and several participants valued cardiac MRI as an alternative to repeated cardiac CT, associating this with reduced radiation exposure and greater perceived safety. Participants therefore appeared willing to accept remote scanning that gave local access to specialist services.

The experienced equivalence reported in the results should be interpreted with care. Conventional MRI already separates the patient from the operator, who works from an adjacent control room. Remote MRI acquisition extends that separation from a few metres to tens or hundreds of kilometres, with the operator's exact location variable to the patient, which may produce little perceptible change at the patient interface. That 13 of the 16 interviewees did not distinguish remote from conventional operated cardiac MRI indicates that the remote element was imperceptible to them. However, this group had self-selected into an interview and was largely favourable towards the service. The more substantive observation is that participants who knew a distant specialist was controlling the acquisition still expressed confidence in the arrangement and reported no additional burden. Two features may account for this. Video consultation which requires patients to manage devices and connectivity and has shown only moderate acceptance in cardiology [31]. Remote MRI, by contrast, places no technical demand on the patient, due to interaction remains with the on-site Patient Manager and the scanner itself. In addition, the continuous presence of that Patient Manager provided a local human anchor, which plausibly explains why greater operator distance did not disturb the perceived safety of the examination. Patient acceptance of care delivered by a physically absent specialist is one precondition, among several, for delivery models that bring centralized expertise to peripheral sites. The operational, economic, and clinical preconditions remain to be established.

Evidence on patient experience of remote cardiac MRI remains sparse. The only previous study of this model reported technical performance, safety, and workflow comparable to on-site scanning, but did not systematically assess patient experience [32]. Tele-echocardiography studies likewise report high diagnostic accuracy when expert interpretation is ensured, with patient-reported experience rarely a primary outcome [33, 34]. In teleradiology, an island primary care service reported high satisfaction, with benefits including remaining locally (83%), avoiding travel (68%), and faster service (67%) [35]. Education and digital confidence predict acceptance of remote cardiovascular services,[31] and the high acceptability observed in this advantaged cohort is consistent with that pattern.

By including both qualitative and quantitative methods, we ensured a comprehensive and valid insight into the patient group, while nuancing the patient experience of remote MRI as part of the greater patient pathway. By including the patient perspective, we can create real-world and patient-centred improvements within the health care system, especially for those who need it the most [36]. Further, it is clinically relevant since there is a growing need for exploiting the resources allocated to sustain the desired degree of specialized health care services, which we as society wish to maintain in the future, while also balancing the growing geographical and social inequality in access to health care. Our results highlight different clinical scenarios due to the cohort spanning a regional hospital 75 km from the tertiary centre and an island population requiring air travel. The pilot was therefore deliverable across a wide range of distances and degrees of isolation, although it did not evaluate operational scalability or cost.

It is important to clarify that this study has some clear limitations. Regarding inclusion of participants, we do not know why 38 participants were not asked to participate; however, it was most likely due to time constraints and competing priorities. This meant that in total, almost half of the patient group did not participate in the study, making selection bias relevant. Further, the cardiologists referring patients to remote cardiac MRI during the pilot period describe that they might have been reluctant to refer patients who had mobility problems or who were otherwise challenged, to an area of the hospital with a potentially lower staff presence than normally. However, other cardiologists also mention that they referred patients to remote cardiac MRI when they saw patients unable to endure longer travel times. Around half of the pilot remote cardiac MRI scans were monitoring check-up. Having this big part of the patient group presenting with congenital or long-term cardiac disease can also explain part of the reason the participants indicate a high level of health literacy, since they will have years of experiences with navigating their disease and the health care system.

Overall, this indicates that our findings may represent a part of the greater patient group, which exhibits a higher level of resources in relation to health and the health care system in general. This points to a missing part of the actual patient group, who experience more limited resources in relation to health, and who might experience an even greater treatment-burden reduction with Remote technology as part of their patient journey, since they can gain access to health care closer to their home, thereby limiting the resources they need to use.

The findings may transfer to other specialist imaging services where expertise is geographically concentrated, acquisition depends on the operator, and a trained staff member is physically present with the patient. However, transfer to settings without an on-site equivalent of the Patient Manager should not be assumed.

For future research we wish to point to the importance of understanding remote technology in a broader sense, and how technology can change and is changing the way the health care system operates and influence patient experiences, with an un-wavering focus on access to health care and inequality in health.

# Conclusions

To our knowledge, this study provides the first insight into patient acceptability of remote cardiac MRI acquisition across real-world implementation. Participants consistently described the model as a “win-win” and reported an equivalent scan experience to conventional scans. They valued access to cardiac MRI as an alternative to repeated cardiac CT in some monitoring pathways and expressed confidence in specialist oversight despite the operator being physically absent.

Delivery models of this kind offer a solution to reducing geographic inequality in access to specialist cardiovascular imaging that does not depend on relocating either patients or specialists. This study establishes that the patient-side condition was met in an early cohort. Equitable implementation will require deliberate inclusion of populations underrepresented in this pilot, so that remote delivery of specialist cardiovascular imaging reduces, rather than reproduces, existing inequalities in access to advanced diagnostics.

# Abbreviations

MRI Magnetic Resonance Imaging

CT Computed Tomography

# Declarations

### Ethics approval and consent to participate

According to Danish regulation and guidelines, there was no need for ethical review due to the study not including biological material and all participants gave informed consent [22]. In compliance with the Declaration of Helsinki,[21] participants received written information about their rights and the study procedures before providing written informed consent. Before interviews, participants received verbal re-information and provided verbal consent. All data were pseudonymized and stored securely in compliance with General Data Protection Regulation requirements [20]. The study was reported to the relevant Danish (Forskningsjura in Region Hovedstaden, Blegdamsvej 60B, 2100 Copenhagen) and Faroese (Forstjóri at Sjúkrahúsverkiõ, J.C. Svabosgøta 41-49, 100 Tórshavn) authorities (p-2023-15041; DBA ID: 137).

### Consent for publication

Not applicable.

### Availability of data and materials

The datasets generated and analysed during the current study are not publicly available due to the privacy and sensitive nature of the participants’ experiences. De-identified data are available from the

corresponding author on reasonable request.

**Competing interests**

The authors declare no competing interests.

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**Authors' contributions**

M.S., M.L., N.V., and M.A.V.L. conceptualized the study. F.S.W. curated the data, performed the formal analysis, and created the visualizations in strong collaboration with M.S. M.K., and M.A.V.L.. M.A.V.L. acquired the funding. F.S.W., M.S., M.L., and J.J. conducted the investigation. F.S.W., M.S., M.L., M.K., and M.A.V.L. developed the methodology. F.S.W., M.S., M.L., J.J., and M.A.V.L. were responsible for project administration. S.B., A.B.M., J.J., and K.M. provided resources. M.K., N.V., and M.A.V.L. supervised the work. F.S.W. and M.A.V.L. wrote the original draft of the manuscript, and all authors reviewed and edited it.

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## Figures

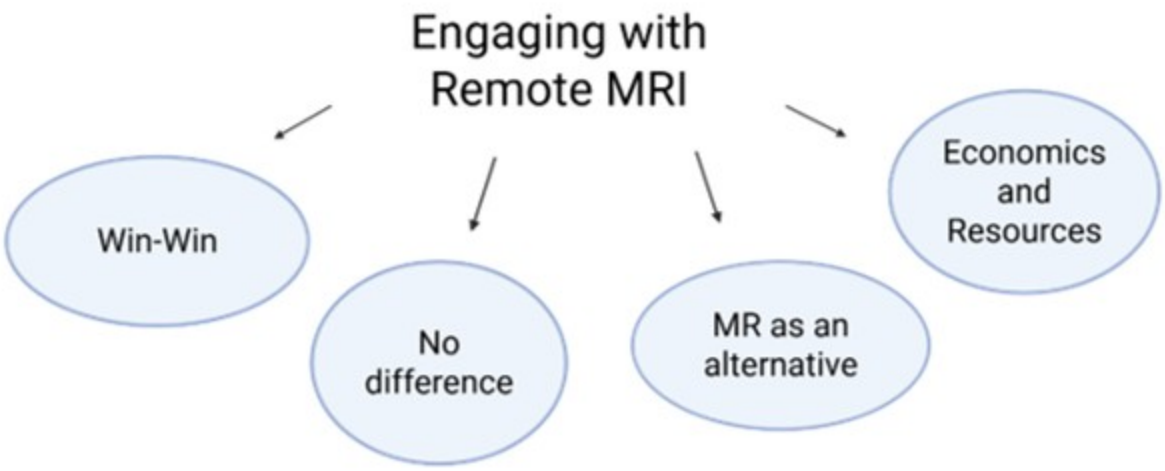



**Figure 2**

Thematic Map of the Interview Analysis

*The Thematic Map depicting the Main Theme with Sub Themes*

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